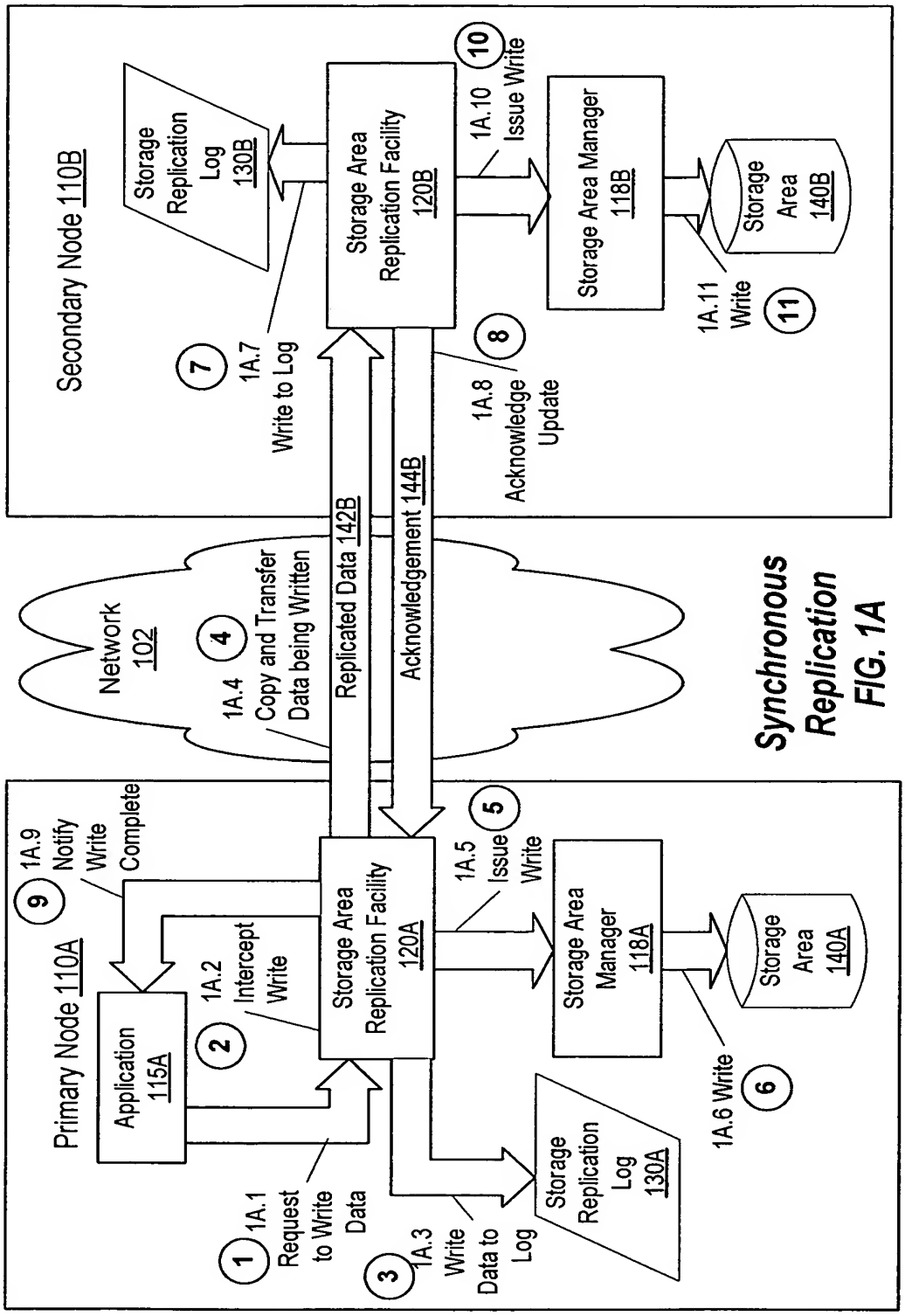
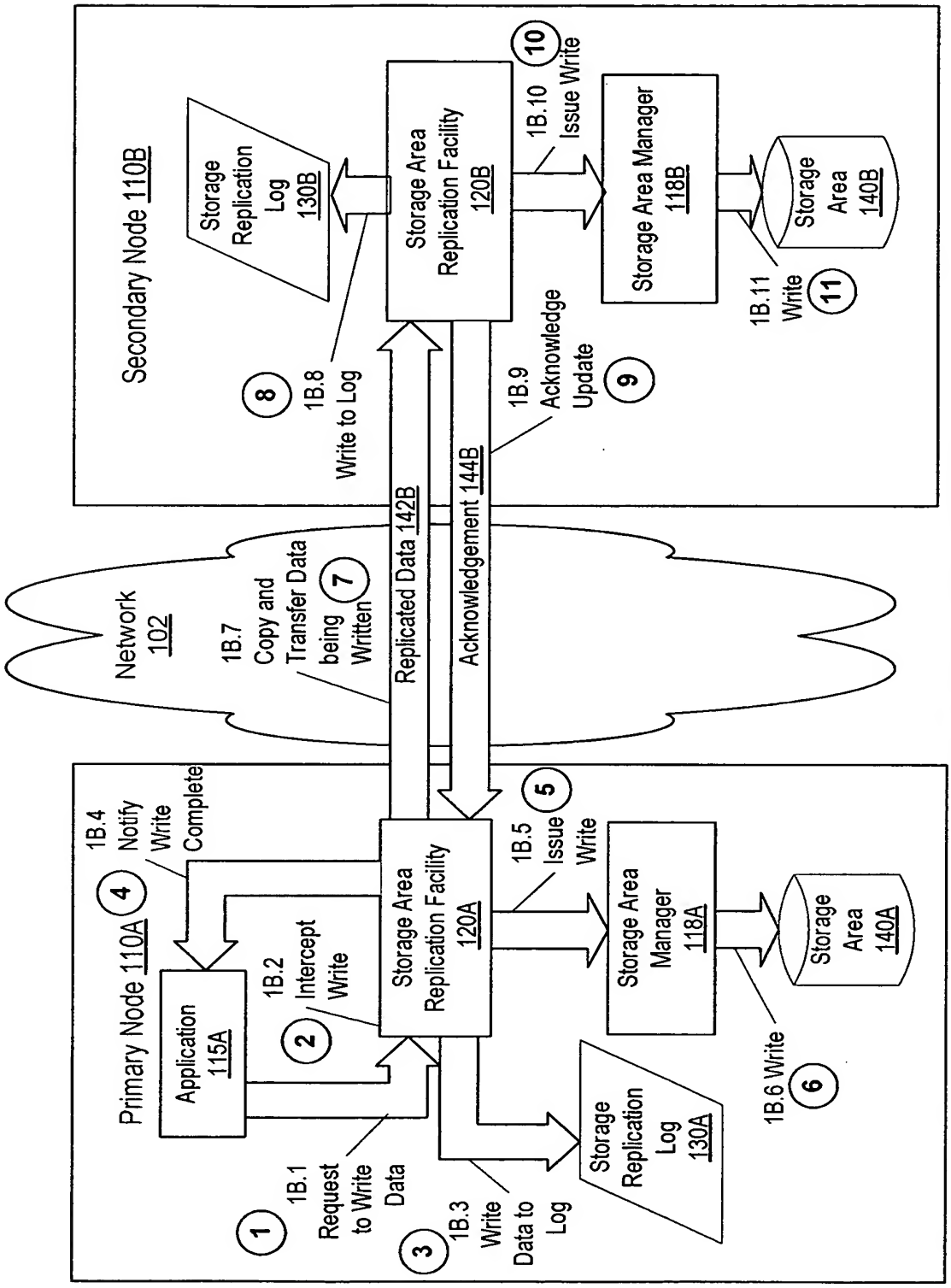
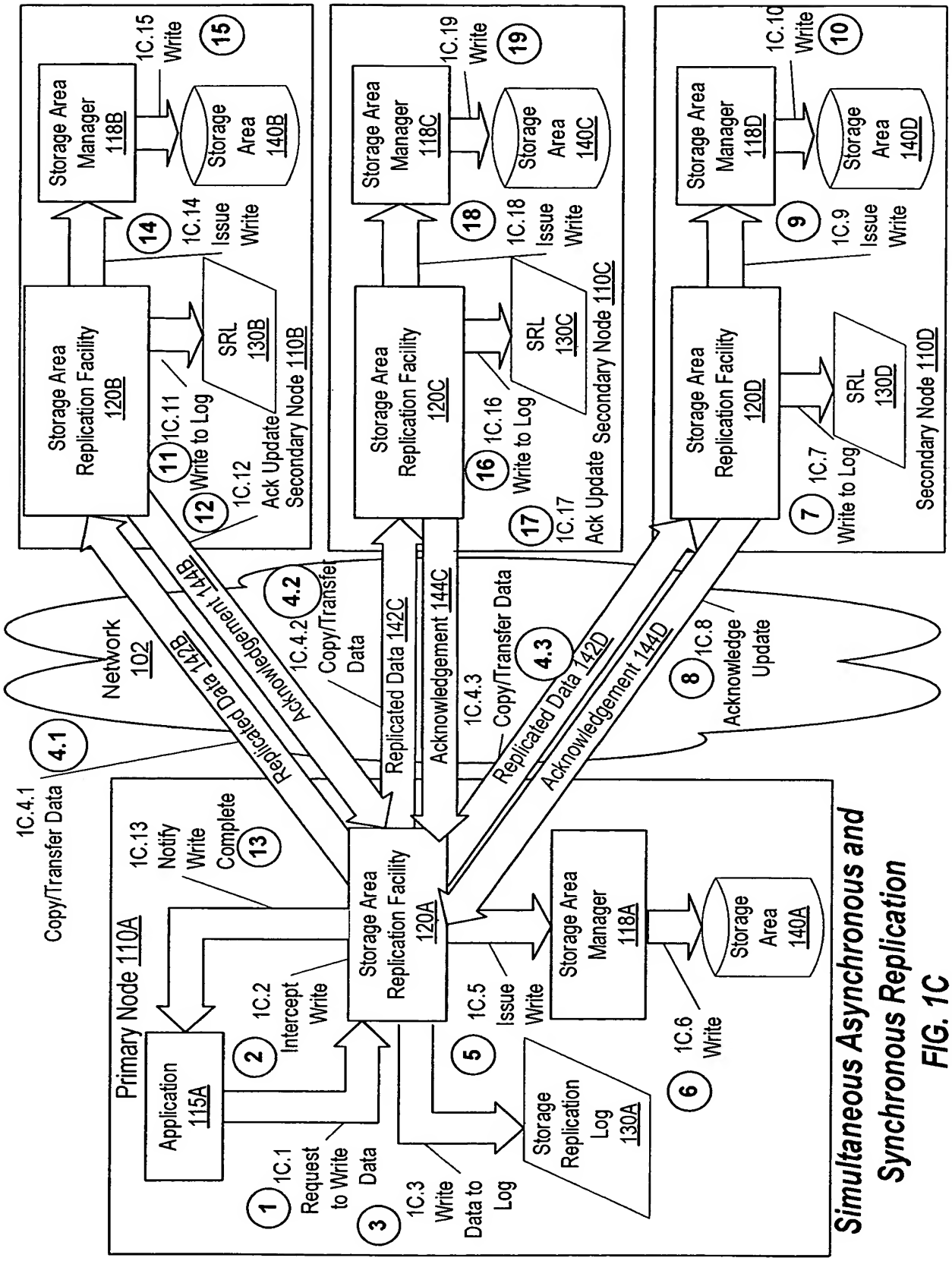


Synchronous Replication
FIG. 1A



Asynchronous Replication
FIG. 1B



Simultaneous Asynchronous and Synchronous Replication

FIG. 1C

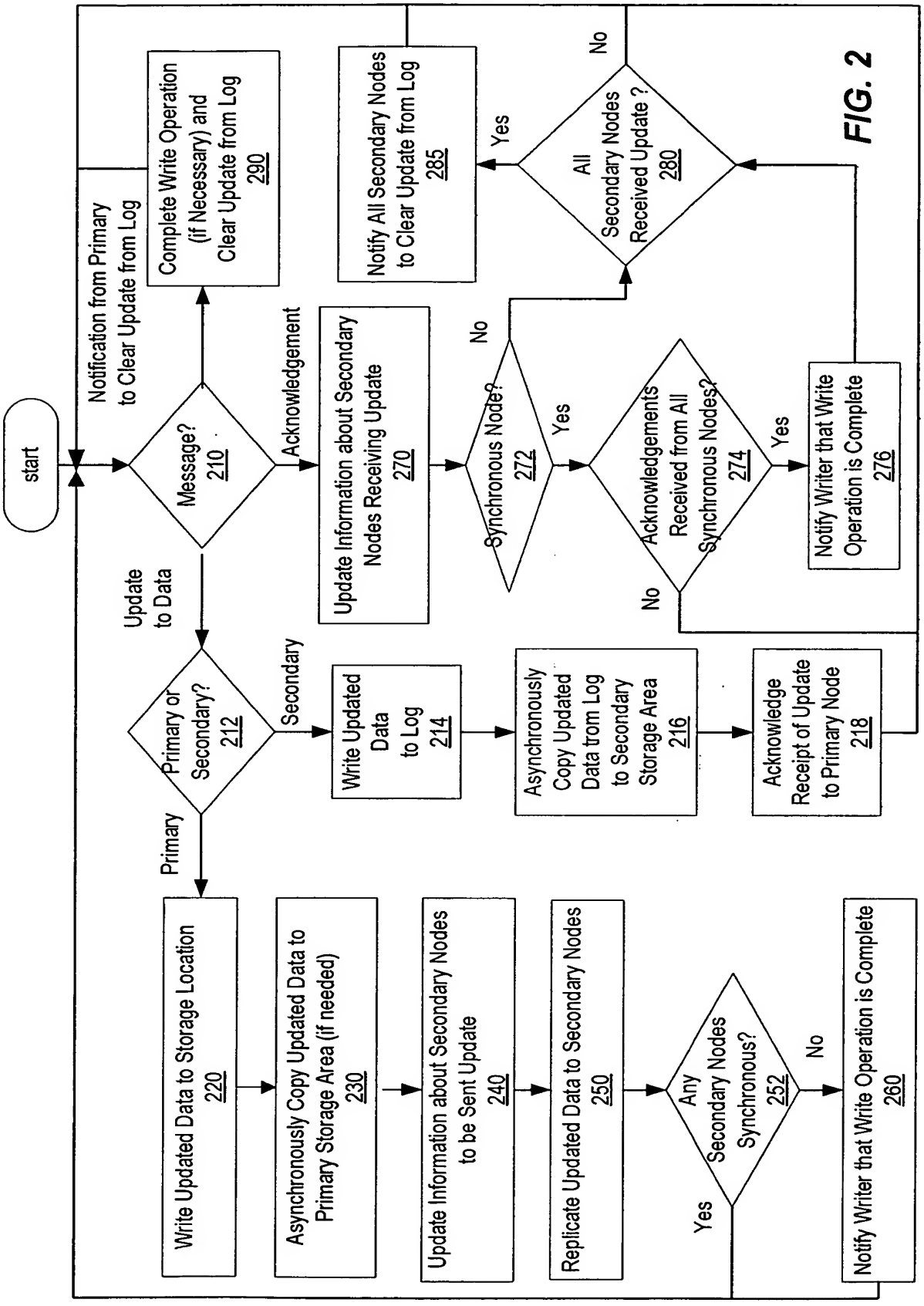
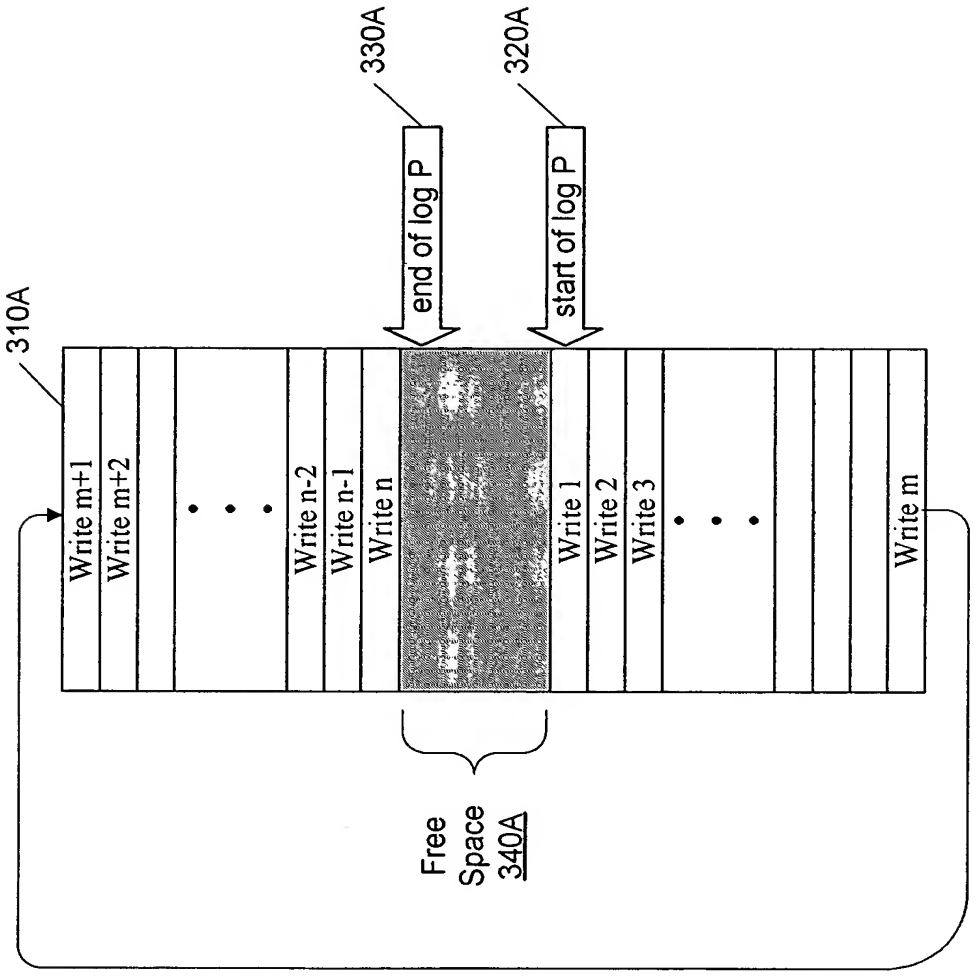
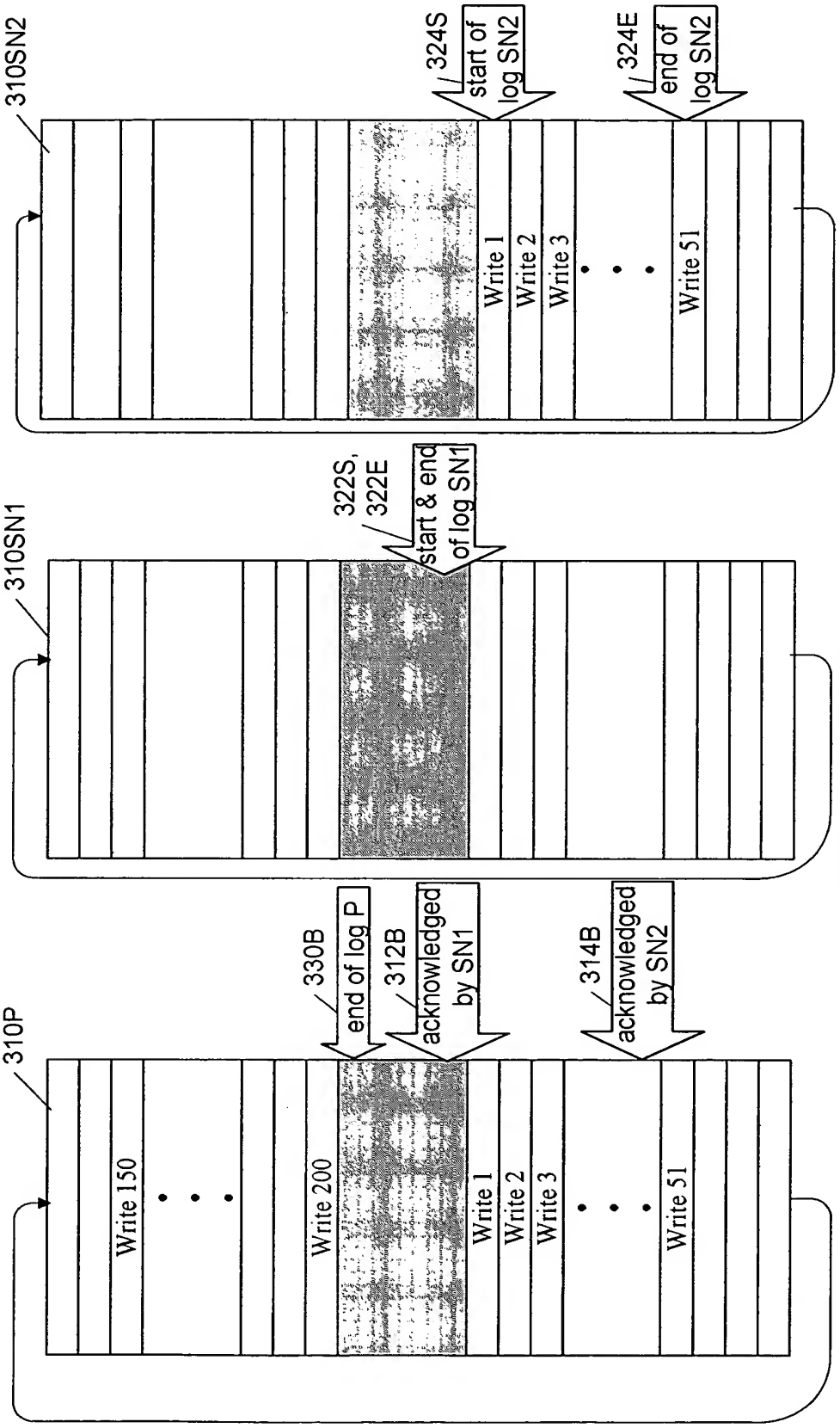

start
Message? 210
Notification from Primary to Clear Update from Log
Complete Write Operation (if Necessary) and Clear Update from Log 290
Acknowledgement
Update Information about Secondary Nodes Receiving Update 270
Synchronous Node? 272
No
Yes
All Secondary Nodes Received Update ? 280
No
Yes
Notify All Secondary Nodes to Clear Update from Log 285
Acknowledgements Received from All Synchronous Nodes? 274
No
Yes
Notify Writer that Write Operation is Complete 276
Update to Data
Primary or Secondary? 212
Secondary
Write Updated Data to Log 214
Asynchronously Copy Updated Data from Log to Secondary Storage Area 216
Acknowledge Receipt of Update to Primary Node 218
Primary
Write Updated Data to Storage Location 220
Asynchronously Copy Updated Data to Primary Storage Area (if needed) 230
Update Information about Secondary Nodes to be Sent Update 240
Replicate Updated Data to Secondary Nodes 250
Any Secondary Nodes Synchronous? 252
Yes
No
Notify Writer that Write Operation is Complete 260

FIG. 2



Storage Replication Log
FIG. 3A



Storage Replication Log

FIG. 3B

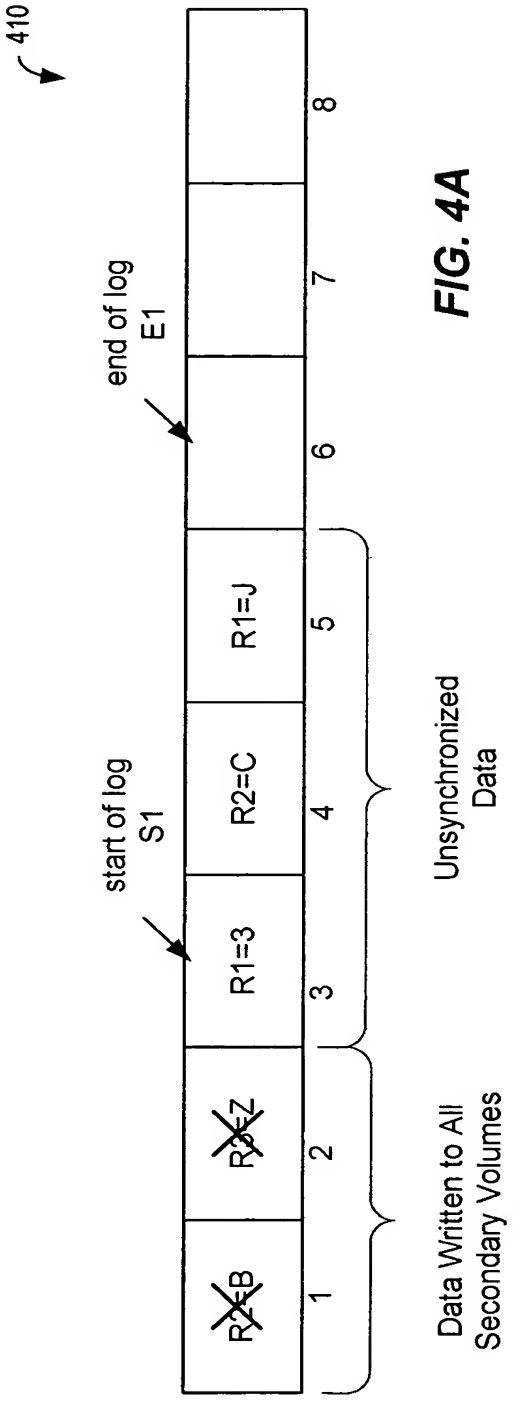

410
start of log
S1
end of log
E1
R1=3
R2=C
R1=J
1
2
3
4
5
6
7
8
Unsynchronized
Data
Data Written to All
Secondary Volumes

FIG. 4A

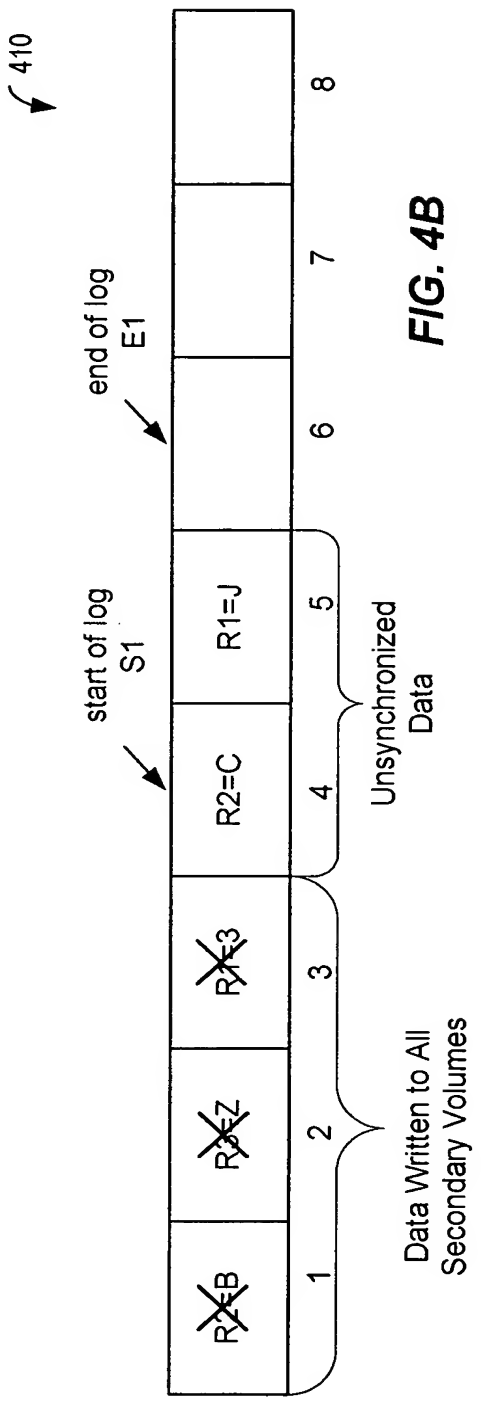

410
start of log
S1
end of log
E1
R2=C
R1=J
1
2
3
4
5
6
7
8
Unsynchronized
Data
Data Written to All
Secondary Volumes

FIG. 4B

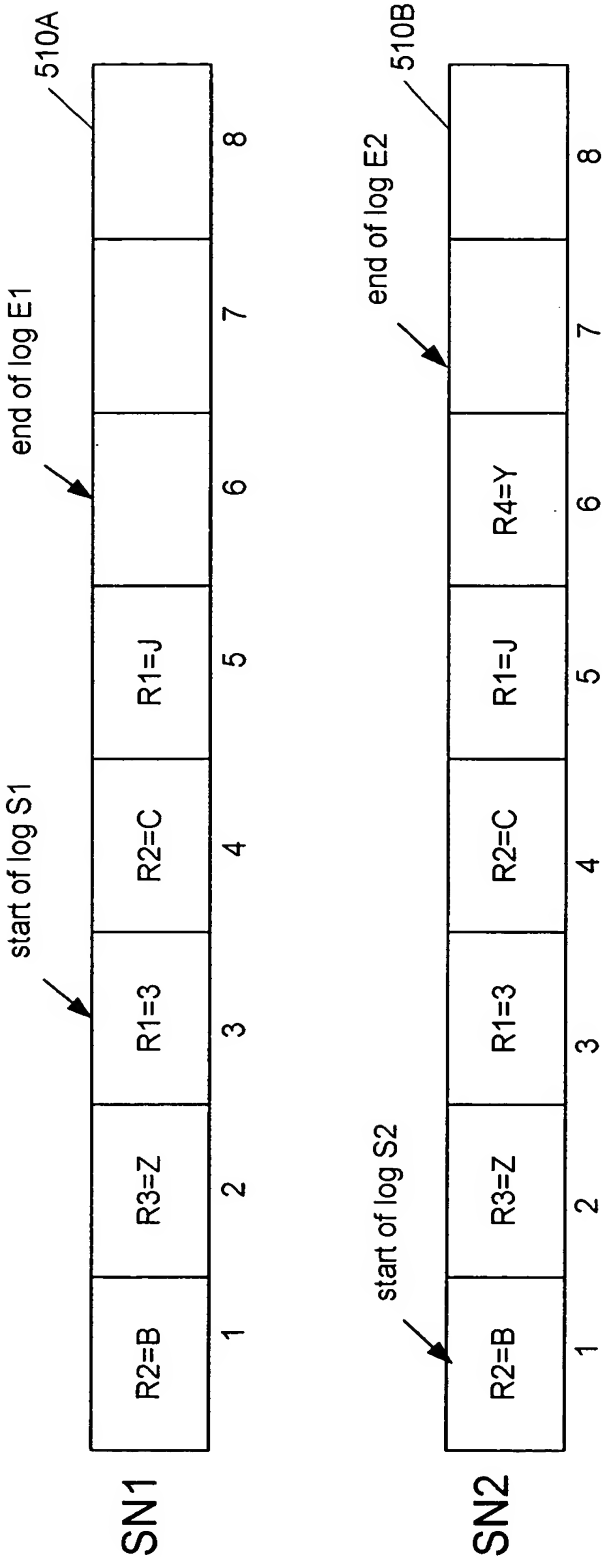

510A
end of log E1
start of log S1
R2=B
R3=Z
R1=3
R2=C
R1=J
1
2
3
4
5
6
7
8
SN1
510B
end of log E2
start of log S2
R2=B
R3=Z
R1=3
R2=C
R1=J
R4=Y
1
2
3
4
5
6
7
8
SN2

FIG. 5A

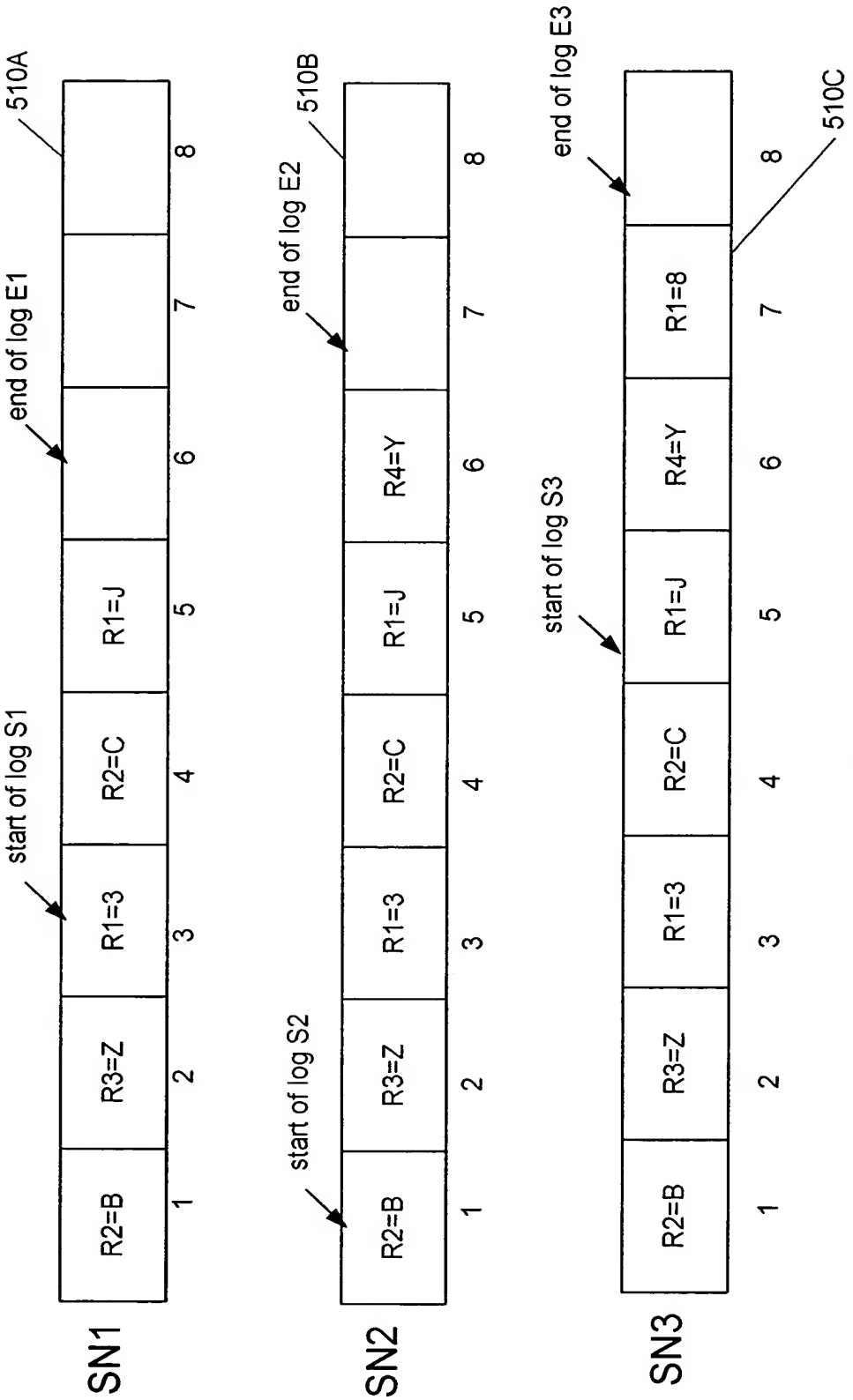

SN1
SN2
SN3
510A
510B
510C
start of log S1
start of log S2
start of log S3
end of log E1
end of log E2
end of log E3
R2=B
R3=Z
R1=3
R2=C
R1=J
R4=Y
R1=8
1
2
3
4
5
6
7
8

FIG. 5B

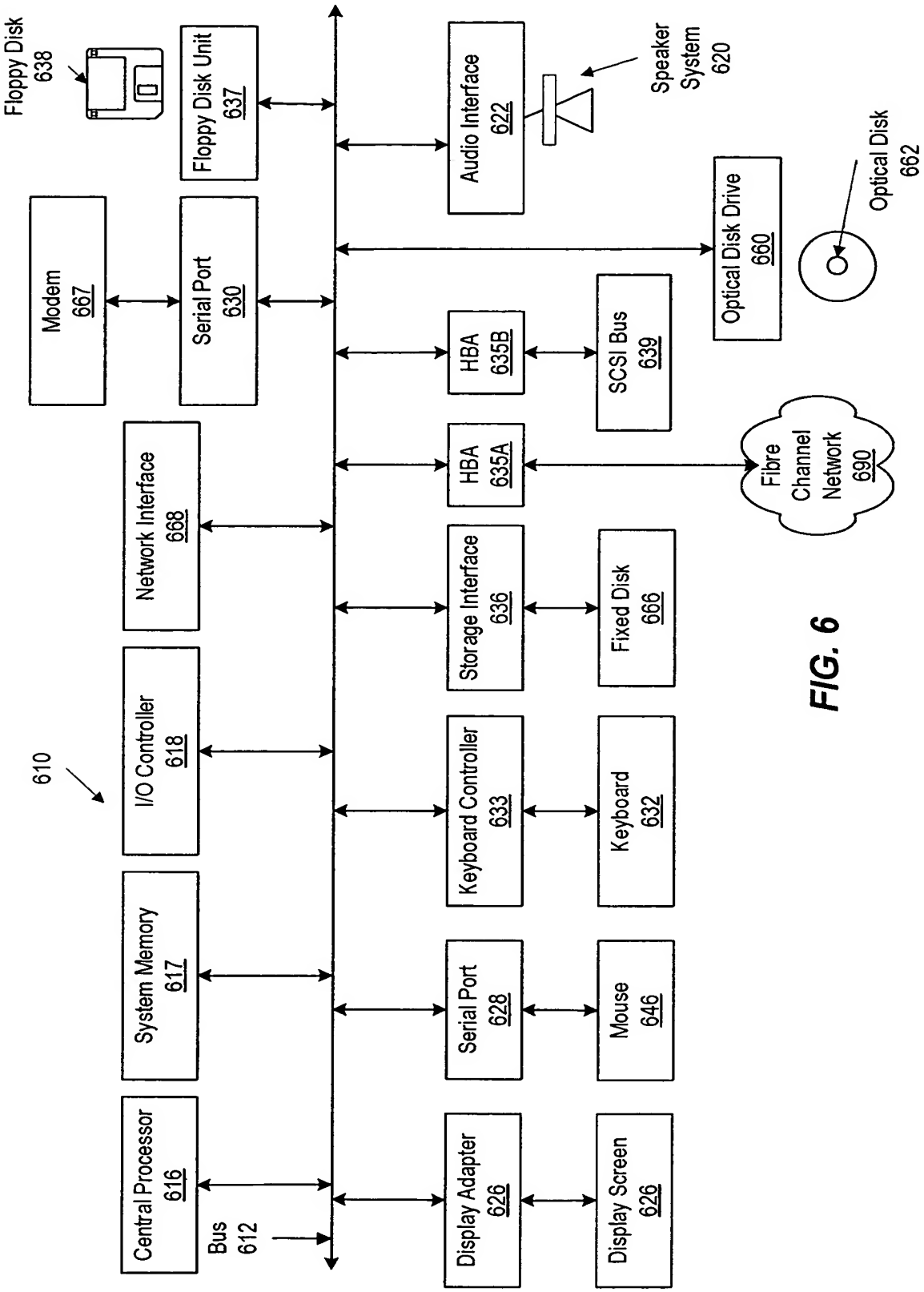

Floppy Disk 638
Floppy Disk Unit 637
Audio Interface 622
Speaker System 620
Modem 667
Serial Port 630
Optical Disk Drive 660
Optical Disk 662
HBA 635B
SCSI Bus 639
HBA 635A
Fibre Channel Network 690
Network Interface 668
Storage Interface 636
Fixed Disk 666
610
I/O Controller 618
Keyboard Controller 633
Keyboard 632
System Memory 617
Serial Port 628
Mouse 646
Central Processor 616
Display Adapter 626
Display Screen 626
Bus 612

FIG. 6